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UNITED STATES
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BUREAU OF MINES
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INFORMATION CIRCULAR

CHALK AND WHITING

BY

OLIVER BOWLES

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

CHALK AND WHITING[1]

By Oliver Bowles[2]

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INTRODUCTION AND ACKNOWLEDGMENTS

Whiting or Paris white is a fine-grained preparation of calcium carbonate having a wide variety of uses. Until recent years it was prepared almost exclusively from certain north European chalks. With the curtailment of imports of European chalk during the World War of 1914-18, however, finely ground limestone of domestic origin was used more extensively to satisfy the American demand.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7197."

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To encourage the domestic industry, the Bureau of Mines in 1931 undertook a study of the preparation of whiting from United States raw materials. As a part of this study, domestic products were compared with European whitings, and a detailed report on results has been issued.[3] Some of the material in the present publication has been abstracted from that report, but most of it is a revision of an earlier report by Bowles.[4]

Acknowledgment is made to Dr. Duncan McConnell, former assistant mineral economist of the Bureau of Mines, for valuable assistance in compiling certain sections of this report.

DEFINITIONS

The following definitions will clarify the text that follows:

Limestone. - Any natural, stratified rock composed principally of calcium carbonate, the double carbonate of calcium and magnesium, or intermediate mixtures of the two carbonates. Limestones containing 5 to 20 percent MgO are known as magnesium limestones and those of more than 20 percent MgO as dolomitic limestones.

Marble. - A variety of limestone in which the essential carbonate constituents have been completely recrystallized to form an interlocking structure, resulting in a dense stone capable of being polished.

Marl. - This term (which has suffered from rather indefinite usage) is properly applied to unconsolidated deposits high in calcareous material. Rarely is it pure enough for use as whiting.

Chalk. - Considerable confusion attends the use of the term "chalk," but it may be defined as a fine-grain, light-color variety of friable limestone composed of the calcareous remains of microscopic marine organisms. It is usually dull, earthy, or opaque in appearance, but it is not "amorphous".[5]

The micro-organisms contributing to the formation of chalk are chiefly coccolithophores and rhabdoliths, although the remains of foraminifera usually are present also. The chalk beds of both northwestern Europe and North America are of Cretaceous age. The American deposits are true chalks in every sense and show marked similarity to European chalks in composition and physical properties.

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[3] Wilson, Hewitt, and Skinner, Kenneth G., Occurrence, Properties, and Preparation of Limestone and Chalk for Whiting: Bureau of Mines Bull. 395, 1937, 160 pp.

[4] Bowles, Oliver, Chalk, Whiting, and Whiting Substitutes: Bureau of Mines Inf. Circ. 6482, 1931, 13 pp.

[5] Johnston, J., Merwin, H. E., and Williamson, E. D., The Several Forms of Calcium Carbonate: Am. Jour. Sci., ser. 4, vol. 41, 1916, p. 490. Boswell, P.G.H., A Piece of Chalk: Sci. Progress, vol. 28, 1933, pp. 193-202. Wilson, Hewitt, and Skinner, Kenneth G., Work cited, p. 7.

Whiting. - Finely ground, pulverized, powdered, or chemically precipitated calcium carbonate of good white color is known as whiting. The Bureau of Mines recognizes different classes of whiting, according to the raw materials used in their preparation, as follows: 6/

Chalk whiting - prepared from true chalk.

Limestone whiting - prepared from limestone.

Marble whiting - prepared from marble (marble flour)

Dolomite whiting - prepared from dolomite (calcium-magnesium carbonate).

Precipitated whiting - prepared by reaction of milk of lime with carbon dioxide or by some similar chemical reaction (so-called precipitated chalk).

Surface-treated whiting - prepared by various methods involving superficial coating of the particles with certain organic compounds.

The classification of whiting materials presented herein will, it is believed, eliminate some of the confusion that now exists. For example, in the present usage the term "precipitated" does not necessarily indicate that the product was obtained by chemical reactions in processing plants, but it may be used to refer to very finely ground natural materials. "Hard" and "soft" do not seem particularly suited to classification of whitings, and ambiguity immediately arises if the distinction is one involving whether or not the product is ground. Although chalk occurs in nature in a finely divided state (the individual grains being microscopic) and although it is moderately friable in its natural condition, grinding is common practice in its preparation for use as whiting.

USES AND SPECIFICATIONS

The requirements for whiting are quite variable, depending on the several diverse uses, and specifications are lacking except in a few instances. In general, color, fineness, and freedom from grit are important in determining quality. Standard methods for determining certain specific properties have been established, but sales are based largely upon samples.

6/ Some of these terms have appeared at various times in the literature. For example, "limestone whiting" and "chalk whiting" are to be found in a paper prepared in connection with a public hearing held in the office of the United States Tariff Commission, Washington, D. C., June 20, 1928. See Rock Products, vol. 31, 1928, pp. 74-80.

Market quotations are based upon certain grades, such as commercial, gilders, Paris white, English cliffstone, etc.; but these terms are used loosely and do not guarantee strict uniformity of the product.

Ceramic whiting. - An important use of whiting is as a constituent of glazes and enamels for ceramic products. Chalk, marble, limestone, or precipitated whiting may be used, chemical purity being an important factor. Ceramic whiting is divided into two classes, both of which must contain not less than 97 percent total carbonates and not more than 0.25 percent iron oxide, 2 percent silica, and 0.1 percent sulfur trioxide. Class 1 must contain 96 percent or more calcium carbonate and not more than 1 percent magnesium carbonate. Class 2 may contain as much as 8 percent magnesium carbonate and as little as 89 percent calcium carbonate. 7/

Paints. - Cold-water paints and calcimine are composed essentially of a filler, a pigment, and an organic colloid. Whiting is commonly employed in these products. Whiting is a standard "extender" for flat wall paints and enamel undercoats. Both precipitated whiting and chalk whiting are used, special types of surface-treated whitings being preferable under certain conditions. Factors governing the uses of extenders are (1) particle size and size distribution, (2) textural features, (3) particle shape, (4) chemical reactivity, (5) oil absorption, (6) color, and (7) specific gravity. Because of its low refractive index as compared with white lead and zinc oxide, whiting does not have high opacity or covering power. However, chalk whiting has somewhat better opacity than limestone or marble whiting. This is probably due to the characteristic shapes of the chalk particles, which cause greater scattering of the light.

Although large quantities of whiting are used by the paint industry, specifications for this use have not been published. Chalk whiting is preferred, and about 50 percent of the chalk imports are applied to this use.

Rubber. - The choice of proper fillers in rubber manufacture has a pronounced influence on the quality of the finished product. Fillers perform several functions, such as toughening, diluting, reinforcing, activating, coloring, and increasing heat resistance. Any one particular filler may have favorable properties for one or more purposes but objectionable properties from other standpoints. Rubber manufacturers are more interested in the physical properties of fineness, production of strength, and workability than in chemical composition; nevertheless, whiting for rubber is restricted to types consisting of nearly pure calcium carbonate.

7/ American Ceramic Society, Standard Specifications for Materials. Ceramic Whiting: Jour. Am. Ceram. Soc., vol. II, 1928, p. 378.

In general, fillers for rubber should have extremely fine particle size, should be easily dispersible, and should have excellent bonding properties with the rubber. Some of the surface-treated whitings have properties superior to untreated materials in these respects.

Putty. - Whiting and linseed oil usually are the chief constituents of putty, although white lead is sometimes used and may constitute 10 percent or more of the pigment. Other pigments and other carriers also are used. Fineness of grain size and freedom from grit are desirable. Chalk whiting produces a "long" putty with excellent stretching power, which is preferable for certain purposes. "Short" putty, which is adapted to glazing of metal sash, is prepared from whiting of other types. It is claimed that small additions of calcium oxide (quicklime) will promote rapid hardening. Alkali is an objectionable impurity sometimes found in precipitated whitings, particularly in certain byproduct precipitates, and its presence may cause reaction with the linseed oil, resulting in saponification. Low oil absorption is an important consideration in putty. Putties made of imported chalks usually have an oil absorption as low as 15 percent.

Federal specifications for putty for glazing wood sash (TT-P 791a) require the use of chalk whiting and raw linseed oil, whereas the specifications for putty for glazing metal sash (TT-P 781) do not specify the type of pigment to be used.[8] The American Society for Testing Materials has published specifications for putty (D317-33)[9] About 10 percent of all whiting is used in the manufacture of putty.

Paper. - Fillers are employed in paper manufacture to increase opacity and improve printing quality. Precipitated whiting and various finely ground natural whitings are employed as fillers but are used more extensively as coating pigments for printing papers. Many factors must be considered in the choice of proper loading and coating materials, but one requisite is fineness of grain size.

Other uses. - Many diversified uses of whiting have been developed, but it is not within the scope of this paper to discuss these uses in detail. However, it seems desirable to list some of the products in which whiting is employed, as follows: White ink, fabric filler, dressing for white shoes, soap, cosmetics, crayons, wire insulation, dentifrices, explosives, medicines, metal polish, insecticides, linoleum, oilcloth, gypsum plaster, sealing wax, acoustic tile, paper plastics, stock feeds, cigarette paper, picture-frame molding, roofing cement, calking compounds, dolls, and fireworks. Numerous chemical and industrial processes utilize whiting in such a way that it is not incorporated in the finished product.

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[8] Copies of Federal specifications may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

[9] Copies of these specifications may be obtained from the American Society for Testing Materials, 260 Broad Street, Philadelphia, Pa.

In addition to the material sufficiently light in color to be known as whiting, darker calcium carbonate powders are used as fillers in asphalt, rubber, and fertilizers. Under the name rock dust, pulverized limestone is used for the prevention of dust explosions in coal mines. It is somewhat difficult to draw sharp lines of demarcation between whiting and other calcium carbonate powders; but to deserve the name whiting, the product must be white, or nearly so, and should be ground to pass 200-mesh or finer.

PRODUCTION

Very little domestic chalk is used in the preparation of whiting, most of which is made from limestone and marble. The records of the Bureau of Mines do not indicate the use of marl as a raw material for whiting. Few marls are white enough for such use.

The only statistics available on domestic production of whiting are for limestone whiting, as given in the following table. These figures may not be complete, because some companies do not report their sales in enough detail to permit segregation of whiting uses.

Limestone whiting produced in the United States, 1931-40

Year	Short tons	Value	Year	Short tons	Value
1931 ..	75,420	$408,880	1936 ..	179,110	$894,913
1932 ..	76,020	386,191	1937 ..	194,080	923,494
1933 ..	93,070	481,677	1938 ..	145,170	671,842
1934 ..	97,340	509,893	1939 ..	175,460	948,528
1935 ..	147,910	563,514	1940 ..	207,910	1,242,448

OCCURRENCES OF WHITING RAW MATERIALS IN THE UNITED STATES

Alabama[10]

The Selma chalk of Cretaceous age extends as a belt across Alabama, widening toward the west to a maximum of about 25 miles. It outcrops in many places along the Alabama River from Elm Bluff to Old Lexington Landing, and along the Tombigbee River from Paces Landing almost to Moscow. A notable outcrop, about 930 feet in maximum thickness, appears at Selma. Most of the material is impure, and even the purer part, which occurs in the lower beds of the formation, contains not more than about 85 percent calcium carbonate. It consists in part of foraminifera shells and is thus identified with true chalk; but most of the fossils found in it are described as mollusca, oystershells, and other forms.

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[10] For more detailed descriptions see: Adams, G. I., Butts, Charles, Stephenson, L. W., and Cooke, Wythe, Geology of Alabama: Geol. Survey of Alabama Special Rept. 14, 1926, pp. 237-240, 280-284.

Samples of the chalk tested by the Bureau of Mines[11] produced very tough, stiff putties, which might be improved by mixing with limestone whiting or marble whiting to decrease absorption of oil and improve the color.

The Marianna limestone, a uniform, soft, yellowish rock occurring at many places in Monroe, Clarke, Washington, and Choctaw Counties, produced good plastic putties that were slightly darker than the putties obtained from foreign chalk but were lighter in color than those obtained from the Selma chalk. During the first World War it was quarried at Glendon and Walker Springs, Clarke County, and it is said that the purified product was satisfactory for the manufacture of putty or for any other of the uses of true chalk.

Alabama marbles were found to be suitable for putties when finely ground and mixed with Selma chalk. Marble whiting produced in Alabama has many other uses.

Arkansas[12]

Important occurrences of chalk of Upper Cretaceous age have been noted in southwestern Arkansas, chiefly in Little River, Howard, Hempstead, and Clark Counties. The formation is divided into two parts. The lower series of beds, which outcrops near Rocky Comfort, White Cliffs, and Saline Landing, is known as the Annona member, and the upper as the Saratoga. Excellent exposures of the Annona appear in several places; one, which overlooks Little River, is 115 feet thick above water level. The thickness of the section at White Cliffs is 135 feet, and analyses show 79 to 93 percent calcium carbonate and 3 to 12 percent magnesium carbonate. Much of the chalk is massive, white, and somewhat friable. It can be broken into pieces by hand, but a hammer is required for pulverizing.

The Saratoga member lies about 200 feet above the Annona, with clayey beds intervening. It has a maximum thickness of about 50 feet where complete sections have been found. In the numerous outcrops that extend from the vicinity of Saratoga, near West Saline River in Hempstead County, to Little Deciper Creek, near Arkadelphia in Clark County, the material is fairly uniform in character. It is more impure than the Annona beds, the best analyses showing less than 74 percent total carbonate.

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[11] The tests of Alabama chalk materials, as well as those of many other States to which reference is made herein, are those recorded in Bureau of Mines Bull. 395, entitled "Occurrence Properties and Preparation of Chalk for Whiting," by Hewitt Wilson and Kenneth G. Skinner, 1937, 160 pp.

[12] For more detailed descriptions of the calcareous deposits see: Taff, J. A., Chalk of Southwestern Arkansas: Geol. Survey, 22d Ann. Rept., pt. 3, 1902, pp. 687-742. Dane, C. H., Upper Cretaceous Formations of Southwestern Arkansas: Arkansas Geol. Survey Bull. 1, 1929, 215 pp.

From results of Bureau of Mines tests it was concluded that unless improvement can be obtained by admixing white limestone or marble whiting, the Annona chalks can be utilized for putty only where light color is not essential.

California

Although chalk deposits of proved commercial value are unknown in California, a number of white limestones and marbles are ground for the preparation of whiting. They are used for paint, putty, rubber, and other purposes. Whiting produced from ground shells yielded a sticky putty of inferior color. When tested by the Bureau of Mines, it was suggested that additions of limestone whiting might yield a more satisfactory putty.

Colorado

Two Cretaceous limestone formations - the Niobrara and the Greenhorn - occur in Colorado just east of the Front Range in the vicinity of Fort Collins and Colorado Springs. The best material contains more than 90 percent total carbonate, but it is a hard, massive rock quite unlike chalk in physical character.

Florida[13]

Ocala limestone beds ranging in thickness from 50 to more than 500 feet occur extensively in Florida except in the western part. They are somewhat variable in texture but remarkably uniform in chemical composition. The color is white, light cream, or yellow. The Marianna limestone, previously mentioned as occurring in Alabama, occurs also in Jackson County, Fla. It is not as pure as the Ocala but may contain as much as 95 percent calcium carbonate. Hernando County is underlain by the Tampa limestone, and Holmes, Washington, Jackson, Suwannee, and Walton Counties contain exposures of the Glendon limestone, the Byram marl, or both.

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[13] For more detailed descriptions see Cooke, C. W., and Mossom, S., Geology of Florida: Florida Geol. Survey, 20th Ann. Rept., 1929, pp. 47-97.

Bureau of Mines tests show that plastic whitings of good color can be obtained from the soft limestones by admixture of small amounts of more plastic materials such as Alabama chalk, foreign chalk, or ground shell.

Georgia[14]

White marbles occur in several counties in Georgia and are quarried extensively in Pickens County. Whiting manufactured from marble by fine grinding has excellent color and medium oil absorption. Putties chiefly of the "short" variety can be produced, but marble whiting is used more extensively for rubber, paint, ceramic, and other purposes.

Illinois[15]

Both the Burlington and St. Louis limestones are used for the preparation of whiting in Illinois. These materials, according to the manufacturers, are used in paint, putty, insulating compounds, explosives, rubber, and various other products. Krey and Lamar[16] claim that the Okaw, Ste. Genevieve, and Kimmswick limestones have similar possibilities, particularly in southern and southwestern Illinois.

Iowa[17]

Chalk of Cretaceous age (Niobrara group) occurs in western Iowa along the Sioux River between Sioux City and Hawarden, chiefly in Woodbury and Plymouth Counties. It forms prominent bluffs near Westfield, Akron, and Hawarden. The beds ordinarily exposed are 20 to 30 feet thick, but the total thickness probably is 50 feet. The chalk is made largely from shells of an oysterlike lamellibranch identified as Inoceramus. Foraminifera remains have been recorded but are much less abundant. The rock is composed of varying proportions of chalk and limestone. The chalk is described as soft, white to buff in color, and more or less fossiliferous. Soft limestones are interbedded in places although some beds several feet thick are quite free from the firmer limestone. The best of the material contains 86 to 95 percent total carbonate and is low in magnesium.

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[14] For more detailed description of the marbles of Georgia see McCallie, S. W., Marbles of Georgia: Geol. Survey Georgia Bull. 1, 2d ed., 1907, 126 pp.; Bayley, W. S., Geology of the Tate Quadrangle, Georgia: Geol. Survey Georgia Bull. 43, 1928, 170 pp.

[15] For more detailed information see Krey, Frank, and Lamar, J. E., Limestone Resources of Illinois: Illinois State Geol. Survey Bull. 46, 1925, 392 pp.

[16] Work cited, p. 337.

[17] For more detailed descriptions of the formations see Wood, L. W., Road and Concrete Materials of Southern Iowa: Iowa Geol. Survey, vol. 36, 1935, pp. 15-310; Calvin, S., Composition and Origin of Iowa Chalk: Iowa Geol. Survey, vol. 3, 1893, pp. 213-236.

The chalk deposits have not been developed commercially, but limestone, which is abundant in the State, has been pulverized for use as rubber filler.

Kansas[18]

The Niobrara formation of northwestern Kansas contains two members - an upper, the Smoky Hill chalk, and a lower, the Fort Hays limestone, which also contains chalk strata. In a personal communication the Kansas Geological Survey stated that the Fort Hays stratum, which is 60 to 80 feet thick, contains very good grade chalk. Individual beds have an average thickness of about 4 feet and are separated from each other by chalky shale beds averaging about 1 foot in thickness. The upper and much thicker member, the Smoky Hill, is thin-bedded and contains greater amounts of shale.

Kansas has the distinction of being the only State in which true chalk is obtained commercially, according to reports received by the Bureau of Mines. A deposit near Gaylord, Smith County, is utilized for putty, rubber filler, calcimine, and molding; it is not as pure nor has it as good color as imported chalk, but these difficulties are being overcome by improved methods of treatment.

Other limestones occur in the State, but this Bureau has no record of their use for whiting.

Louisiana

Three occurrences of Cretaceous limestones in Louisiana have been described - the Winnfield, the Coochie Brake, and the Bayou Chicot. None is of chalklike consistency, and all are sufficiently consolidated to be used for building purposes The Winnfield is highly crystallized and contains about 98 percent calcium carbonate; the second deposit is sandy limestone. The Bayou Chicot deposit is very small. Although they belong geologically to the chalk formation, these deposits apparently do not possess any of the characteristics of chalk.

18/ For more detailed descriptions see Rubey, W. W., and Bass, N. W., The Geology of Russell County: Kansas Geol. Survey Bull. 10, 1925, 104 pp.; Bass, N. W., The Geology of Western Kansas: Kansas Geol. Survey Bull. 11, 1926, 96 pp.; Landes, K. K., The Geology of Mitchell and Osborne Counties: Kansas Geol. Survey Bull. 16, 1930, 55 pp.

Mississippi[19]

In northeastern Mississippi the Selma chalk, of Cretaceous age, outcrops in a zone 10 to 30 miles wide. It crosses the Tennessee boundary, passes southward for some distance, turns eastward in Noxubee County, and extends into Alabama. In its southern outcrop the rock is 800 to 900 feet thick but thins to 250 feet in the vicinity of Corinth, Alcorn County. In a letter to the writer E. N. Lowe, director of the Mississippi Geological Survey, states that it may scarcely be considered true chalk; rather, it is soft argillaceous limestone much denser than typical chalk. The best of it contains 70 to 84 percent total carbonate, with a magnesium content usually less than 1 percent. Certain parts of the uppermost division, commonly known as rotten limestone, may, however, contain more than 90 percent of calcium carbonate; and by careful selection of purest occurrences, chalk of good quality may possibly be obtained.

Missouri

The Spergen oolitic limestone occurring near Ste. Genevieve is employed to some extent as a paint and rubber filler and for other whiting uses. When tested by the Bureau of Mines, it gave only moderately favorable results as a constituent of putty.

Montana

Cretaceous rocks of the Plains region throughout the eastern two-thirds of Montana contain lenses and concretions of limestone, which have been used locally for lime burning. Bureau of Mines tests of the putty-making qualities of whiting produced from Montana deposits gave encouraging results.

Nebraska

The Cretaceous deposits of Nebraska are similar to those of northwestern Kansas. The most promising source of chalk is a 50-foot lower bed of the Niobrara formation corresponding to the Fort Hays limestone of Kansas. Their tendency to weather to light yellow is a characteristic feature of the rocks. Owing chiefly to admixtures of clay, the limestones vary greatly in composition. Representative analyses show a total carbonate content ranging from 67 to 96 percent, with 1 percent or less magnesium carbonate. Cretaceous exposures occur extensively along the Missouri River and along the Republican Valley from Alma to a point near Superior. So far as is known, the Cretaceous deposits have not been used for production of whiting. Carboniferous limestones have been used for whiting employed in paint and for a number of other

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[19] For more complete information see Crider, A. F., Portland Cement Materials of Mississippi: Mississippi Geol. Survey Bull. 1, 1907, 73 pp.

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purposes, but according to tests made by the Bureau of Mines they will not make putty having satisfactory working properties.

New Jersey[20]

The Franklin formation quarried chiefly in Sussex and Warren Counties is utilized extensively for a wide range of whiting products. It is gray in color and in general is not as finely divided as imported chalks.

Ohio[21]

Limestone whiting from the Clinton formation of southwestern Ohio is used in putty, soap, and the manufacture of electric-light bulbs. It will make a light-gray, short putty.

Pennsylvania[22]

Limestone whiting produced in Pennsylvania is used in paint, rubber, and other products. Marble whiting has been produced from the Conestoga formation near Henderson Station.

South Dakota[23]

Niobrara (Cretaceous) chalk beds occur in the southeastern part of the State. The chalk is exposed in many places along the bluffs of the Missouri River from Yankton to Chamberlain. Ward 24/ states that it outcrops in various places east of the river and also as a more or less continuous band nearly encircling the Black Hills to the west. It has been

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20/ For a description of the Franklin limestone see Lewis, J. V., and Kummel, H. B., The Geology of New Jersey: Geol. Survey New Jersey, Bull. 14, 1915, p. 41.

21/ For a more detailed description of the limestones see Orton, Edward, and Peppel, S. V., The Lime Resources of Ohio Available for Portland Cement Manufacture: Geol. Survey Ohio, 4th ser., Bull. 3, 1904, pp. 88-101.

22/ For detailed descriptions of the calcareous deposits see Miller, B. L., Limestones of Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. M. 20, 1934, 729 pp.

23/ For detailed descriptions of the chalk occurrences see Rothrock, E. P., Preliminary Report on the Chalk of Eastern South Dakota: South Dakota Geol. and Nat. Hist. Survey, Rept. of Investigations 2, 1931, 43 pp.

24/ Ward, Freeman, Chalk: South Dakota Geol. and Nat. Hist. Survey Circ. 6, 1919.

found in digging wells in many widely separated parts of the State. Presumably it underlies most of South Dakota and averages about 150 feet in thickness. It is similar in character to deposits of the same formation in Nebraska and Kansas, which have been described previously. Most of the chalk, however, is dark owing to the presence of carbonaceous matter, but it weathers to lighter shades. Its color probably would limit its use for whiting.

Texas[25]

The Austin chalk, which is the lower part of the Gulf series of Upper Cretaceous age, occurs as a well-defined belt in east-central Texas. From Red River, in the northeastern part of the State, it extends westward near Clarksville, Honeygrove, Paris, and Sherman. From Sherman it extends south and southwestward beneath Dallas, Waco, Austin, and San Antonio, terminating a little southwest of the latter city. The rock is white, friable limestone of chalklike consistency. It is 400 to at least 600 feet thick, and in many places it is remarkably uniform. Although interbedded with clays and shales, in some localities certain beds are composed of nearly pure chalk. Air-dried exposures are brilliant white and after weathering scale off in large conchoidal flakes with earthy fractures. Analyses show a calcium carbonate content ranging from 70 to more than 90 percent and very little magnesium.

Samples tested by the Bureau of Mines gave putties of good working qualities although of darker color and higher oil absorption than those made of imported chalk.

Washington

Whiting manufactured from limestone quarried near Northport, Stevens County, tested by the Bureau of Mines, gave a white, short putty of moderately low oil absorption.

Wisconsin

A pulverized, white, siliceous dolomite prepared in Wisconsin is used as a paint filler. Bureau of Mines tests indicated that it would make a light-cream, fair-working putty of low oil absorption.

25/ For the occurrences of the chalk formations see Udden, J. A., Baker, C. L., and Bose, Emil, Review of the Geology of Texas: Univ. of Texas Bull. 44, 1916, 164 pp.

Other States

In addition to the localities mentioned, chalk occurs in Tennessee and Wyoming, but the occurrences are not extensive and show little possibility of commercial development in the near future. Limestones and marls are widely distributed, but reference to them herein is confined to the more promising occurrences, particularly those that are now used for whiting.

PROCESSES OF MANUFACTURE

Chalk Whiting

Several companies import crude chalk from Europe and prepare it as chalk whiting in plants, most of which are situated on the eastern seaboard.

In the older types of mills, crude imported chalk is ground wet with edge runners. Material is brought to grinders in wheelbarrows or tram cars rather than by mechanical means, because flint balls associated with the chalk are picked out by hand. The milklike suspension of ground chalk is conveyed to a series of settling tanks. Sand settles first and is discarded as waste. The material is graded according to the time required for settling. The highest grade of whiting remains in suspension longest. A crude form of "commercial" whiting is obtained from the first tank. The overflow, which requires a longer period for settlement, supplies the "gilders" or "extra gilders" whiting deposited in the intermediate tanks. From these the overflow passes to a final tank, where, after a still longer period of settlement, a high-grade product known as Paris white is obtained. The overflow from the last tank is returned to the grinding mills. The whiting sludge from the settling tanks is either filter-pressed or evaporated to partial dryness; and final drying, which may occupy 4 weeks, is accomplished in heated chambers. The dried product is disintegrated, passed through a bolting machine, and packed in burlap bags of 50- or 100-pound capacity.

Parsons[26] has described the equipment of a more modern type of mill. Crude lump chalk is passed through crushing rolls and disintegrated in a series of mullers. The sludge, consisting of about 11 parts of water to 1 part of solid, is conveyed to a series of modern bowl classifiers, hydroseparators, and thickeners. A large proportion of the water is thus removed. The pulp is dewatered further in a continuous filter, and final drying is accomplished in a rotary drier that discharges to a storage bin, from which the product is taken for disintegrating and bolting. This type of equipment yields only one grade of whiting at a time. Two or more complete units would be required to produce more than one grade simultaneously. The newer type of equipment greatly increases mill capacity, reduces labor requirements and production cost, and provides a very uniform and dependable product.

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[26] Parsons, A. B., Dressing Crude Chalk by Modern Methods: Eng. and Min. Jour., vol. 116, No. 10, 1923, pp. 415-420.

During the process of manufacture of whiting from chalk there is a shrinkage of about 20 percent in weight; most of the loss is the water content of the crude chalk. Moisture in finished whiting ordinarily does not exceed 0.7 percent.

The process of manufacture of whiting in Kent, England, has been described briefly by Spence27/. The quarried chalk is placed in a 15-foot washing tank and pulverized by means of iron bars suspended from rotating arms. The slurry passes through a 1/8-inch wire screen to a launder, which feeds it to eight trommels fitted with 180-mesh wire gauze. Only the material that passes through these screens is used for whiting. The fine slurry is conveyed to four series of settling pits with eight pits in each series. The slurry fills the first pit, flows over into the second, and so on until the eight are filled. The finer material is thus carried over and settles in the last four pits, the product of which is classed as No. 1 grade; that deposited in the first four is graded No. 2. The overflow from the pits is conveyed back to the washing tank. The whiting is dug out by hand and placed on drying floors, which have heating flues beneath them. After it is dried for 36 hours it is taken by screw conveyor to a swing-hammer disintegrator, which discharges to a bolting trommel. Some is single-bolted and some double-bolted; the latter commands a higher price. Much of the chalk mined in Kent is shipped in crude form, chiefly to the United States.

Although wet methods were used exclusively until recent years, some modern mills employ the more economical dry-processing method. In a typical mill, as described by Mactaggart,28/ the chalk is crushed to 1/2-inch size, dried, pulverized in a hammer mill, and classified by air separation.

Natural Rock Whiting

Limestone and marble are pulverized and graded by two processes - the wet method and the dry method. A typical wet process for manufacturing

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27/ Spence, Hugh S., The Manufacture of Whiting in England: Canadian Min. Jour., vol. 47, No. 38, 1926, p. 907.

28/ Mactaggart, E. F., Making Whiting in England: Rock Products, vol. 44, May 1941, pp. 53-54, 60.

marble flour follows: Marble chips are ground wet in a pebble mill. The mill discharge is pumped to two settling cones, the settled product being returned in closed circuit to the pebble mill and the overflow conveyed to settling tanks. The sediment from the settling tanks, containing about 50 percent moisture, is dried in a type of drum drier that finds successful use in a number of southern plants. The drum, which preferably should be joined by welding to give a smooth surface, is 4 by 10 feet and revolves at 2-1/2 r.p.m. Steam at 75 pounds pressure passes through a hollow shaft to the inside of the drum, beneath which is a rotating shaft with 3/8-inch iron pegs that splash the slurry mixture from a trough to the face of the drum. A series of scrapers, each about 1 foot long and held to the drum with springs, scrape off the dried material to a screw conveyor. Lumps are broken by an impact pulverizer. Drying capacity is 8 to 12 tons per drum per 24-hour day. Much of the whiting made from natural rock is prepared by some wet-ground process, because for certain uses, particularly for the manufacture of paint, waterground material is preferred.

For dry-process grinding the crushed stone usually is passed through a rotary drier and then ground by any one of a variety of processes. Rolls or impact mills of the swinging-hammer type are commonly used for coarser grinding and impact pulverizers or pebble mills for final grinding. Sometimes grading by size is accomplished with air separators supplemented by vibrating screens. Air-floated material is satisfactory for many uses. Several mills are equipped for both wet and dry processes.

Precipitated Whiting

Calcium carbonate obtained as a chemical precipitate (incorrectly called precipitated chalk) is manufactured by treating pure lime (calcium oxide) with carbon dioxide. The lime is first slaked in water to form calcium hydroxide, commonly called slaked lime, according to the following reaction: $CaO + H_2O = Ca(OH)_2$. Enough water is then added to make a thin milk-of-lime suspension. To remove all particles that do not disintegrate, the milk of lime is passed through a fine screen.

Carbon dioxide gas, the second raw material, is manufactured by burning coke. Although precipitated whiting is generally manufactured close to lime kilns, the carbon dioxide gas that passes from the kilns in large quantities is not utilized because it is too impure. Pure gas is desired, and to remove acids, dust, and moisture it is passed through "scrubbers" in the form of towers that contain limestone and excelsior.

The milk-of-lime suspension, which resembles cream, is placed in upright cylinders about 18 feet in height and 6 feet in diameter. Purified gas is blown in at the bottom of the cylinders, and as it comes in contact with lime particles a chemical combination takes place according to the formula $Ca(OH)_2 + CO_2 = CaCO_3 + H_2C$. Recarbonation requires 2 to 3 hours; completion of the reaction is determined by an indicator, such as phenolphthalein. Sometimes closed tanks equipped with agitators are used. The carbonation process must be carried out under exact and carefully controlled conditions. The precipitate of calcium carbonate is dewatered in filter presses, and the filter cakes are dried in hot-air tunnels at about 160° F. Dried cakes are pulverized, and the finished article is packed in paper-lined bags or barrels.

Commercial precipitated whiting is also manufactured as a byproduct at paper mills. Large quantities of caustic soda are required, and this material is manufactured by treating lime with sodium carbonate, calcium carbonate being formed in the process. The chemical reaction may be expressed by the following formula: $CaO + Na_2CO_3 + H_2O = CaCO_3 + 2NaOH$. Calcium carbonate thus formed may contain a fraction of 1 percent alkali, which limits its use. An important application is as rubber filler. The utilization of the calcium carbonate sludge as a substitute for clay paper filler has been noted.

Three leading grades of precipitated whiting are recognized in the trade - extra light, light, and heavy - the principal difference being in density. Most of the production is of the light grade, and its principal use is in the manufacture of toothpaste. Individual manufacturers of toothpaste have their own standards of quality, and there are no exact or generally accepted specifications or methods of testing. Determination of the adaptability of a precipitated whiting for toothpaste manufacture generally includes tests of density, sedimentation, wet bulk, alkalinity, and fineness. The domestic product meets with keen competition from imported material, which is obtained chiefly from England. Not all "precipitated" grades of whiting are produced by chemical reaction, some being in reality water-settled limestone whitings. For this reason the present paper urges the abandonment of "precipitated" as a grade term and advocates its use as a class term for products obtained by the chemical reaction.

TARIFF

Crude chalk, not ground, bolted, precipitated, or otherwise manufactured, is on the free list of the Tariff Act of 1930. Duties imposed on other products were as follows: Whiting, 0.4 cent per pound; precipitated, 25 percent; putty, 3/4 cent per pound.

Through a trade agreement with Belgium dated May 1, 1935, the rate on whiting was reduced to 0.2 cent per pound and on putty to 1/2 cent per pound. A trade agreement with the United Kingdom dated January 1, 1939, reduced the rate on precipitated whiting to 15 percent. These reduced rates apply to products of all countries, unless the President suspends their application to products of a country that discriminates against the commerce of the United States or pursues acts or policies that, in his opinion, tend to defeat the purposes of the Trade Agreements Act.

IMPORTS

Imports of putty have declined greatly within the past few years (except in 1937), and the value of imported putty is only a few hundred dollars each year. The trend of imports of whiting, precipitated whiting, and crude chalk is shown in figure 1. The following tables show imports for the past 3 years by countries and average value of imports.

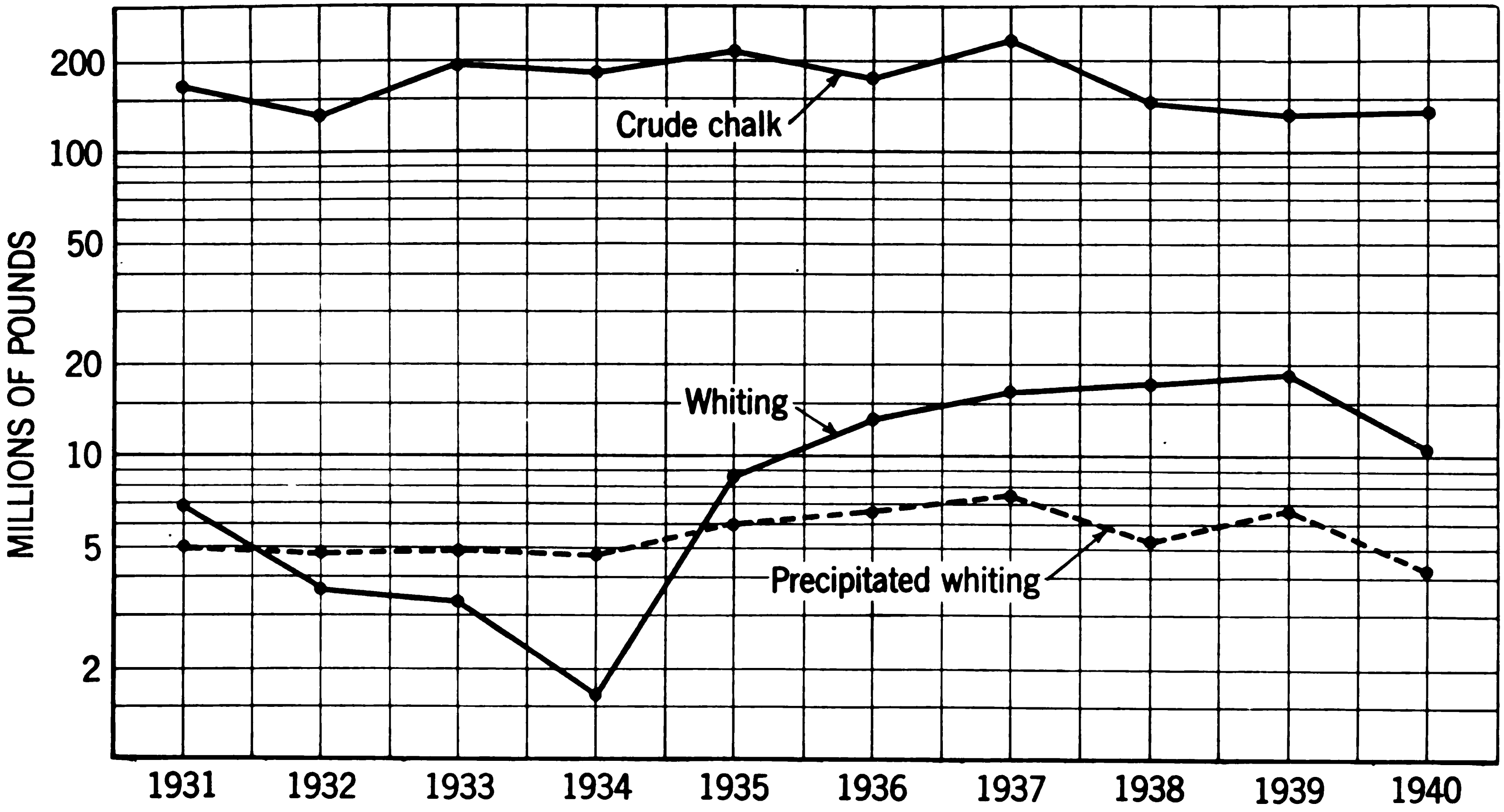

Figure 1.- Imports of crude chalk, whiting, and precipitated whiting. Data from Bureau of Foreign and Domestic Commerce.

Imports of whiting materials into the United States, 1938-40, by country of origin[1]/

CRUDE CHALK

	1938		1939		1940	
	Long tons	Value	Long tons	Value	Long tons	Value
Belgium	2,742	$ 4,618	3,587	$ 5,414	10	$ 124
France	30,555	42,084	23,361	32,997	5,992	6,761
United Kingdom	32,585	40,817	32,705	39,994	55,465	76,103
Switzerland	25	128	-	-	-	-
Mexico	-	-	-	-	10	95
U.S.S.R.	910	2,407	-	-	-	-
Total	66,817	90,054	59,653	78,405	61,477	83,083

WHITING

	1938		1939		1940	
	Pounds	Value	Pounds	Value	Pounds	Value
Belgium	13,273,237	$28,758	14,919,958	$38,992	7,730,471	$29,002
France	88,184	280	373,024	986	694,449	1,685
United Kingdom	1,928,776	10,901	1,938,924	9,871	2,396,800	12,591
Denmark	806,635	2,736	783,215	2,468	45,834	132
Netherlands	545,684	1,348	-	-	-	-
Sweden	817,412	3,025	732,131	2,548	22,068	81
Canada	-	-	-	-	12,000	64
Total	17,459,928	47,048	18,747,252	54,865	10,901,622	43,555

PRECIPITATED WHITING

	1938		1939		1940	
	Pounds	Value	Pounds	Value	Pounds	Value
Belgium	109,458	$ 1,513	-	-	-	-
France	-	-	661	$ 17	2,866	$ 66
United Kingdom	5,044,282	80,776	6,365,022	91,512	4,192,092	62,254
Germany	122,107	2,430	22,046	494	-	-
Czechoslovakia	11,200	104	-	-	-	-
Italy	-	-	5,600	100	-	-
Japan	99,524	1,142	329,474	3,332	67,637	789
Total	5,386,571	85,965	6,722,803	95,455	4,262,595	63,109

Average values of whiting materials imported into the United States, 1928-40[1/]

	Crude[2/] chalk	Chalk[3/] manufactures	Whiting[2/] (excluding precipitated whiting)	Precipi-[3/] tated whiting	Putty[3/]
1928	$1.19	$ 6.75	$ 5.10	$2.77	$2.01
1929	1.17	10.29	5.72	2.31	1.64
1930	1.05	8.84	5.81	2.18	1.74
1931	1.32	6.94	7.53	2.04	1.28
1932	1.05	7.83	5.26	1.75	1.03
1933	1.11	19.72	6.26	1.82	1.10
1934	1.32	14.50	11.47	1.88	1.29
1935	1.49	30.67	6.49	1.60	1.25
1936	1.33	10.78	6.22	1.65	1.64
1937	1.30	18.98	6.02	1.62	.90
1938	1.35	4/54.28	6.04	1.60	1.86
1939	1.31	7.95	6.56	1.42	1.70
1940	1.35	22.10	8.95	1.48	2.63

1/ Based upon data compiled from records of the Bureau of Foreign and Domestic Commerce.

2/ Per long ton.

3/ Per hundred pounds.

4/ Including some chalk crayons.

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